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# Application of point method in risk evaluation for railway transport

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## Abstract

The paper is dealing with risk assessment affecting the hazardous substances shipping by rail; there are identified and assessed risks during the work process. The point method is applied to evaluate how serious risks are. In conclusion, there are suggested particular measures to reduce or eliminate the risks. The main priority of the system should consist in providing a safe workplace, or minimizing and eliminating undesirable factors.

**Keywords:** transport, accident, emergency, hazardous substance, railway, risks assessment

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## 1 Introduction

Safety belongs to basic prerequisites in the transport process; therefore, the emergence of rail accidents as well as emergencies cannot be passed over in the transport process particularly in cases of shipping hazardous substances. Every responsible person involved in transporting hazardous substances is obliged to comply with the relevant rules and regulations so that risks could be prevented as much as possible.

There are a number of methods able to anticipate and mitigate the impacts of accidents. All of these methods follow their purpose and are limited by restrictions. This paper is presenting the point method application. The risk assessment is a highly complex process considering various criteria. Having

identified threatening sources of risks and factors, assessment and subsequent managing risk can follow.

## 2 Current situation

Occurrence and consequences of emergencies and accidents is a worldwide problem. An accident is such an activity of transport participants occurring in case of conflict with legal standards and regulations.

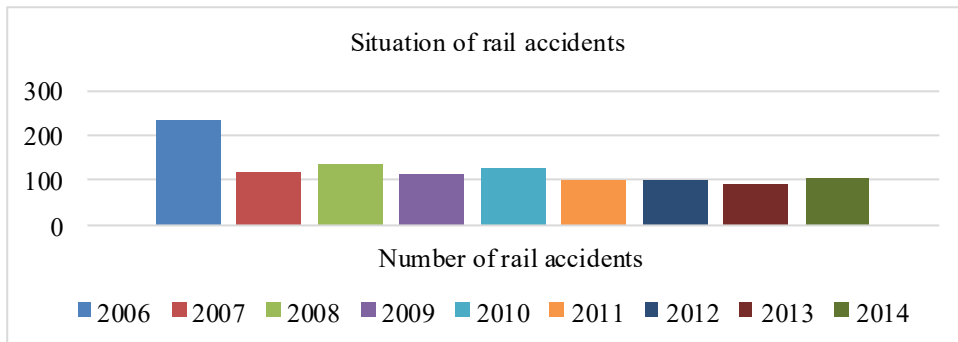
There is an incorrect movement of means of transport, interaction with one another or collision with other traffic participants with consequences resulting in damage, destruction or deterioration of means, vehicles, communications and further damage. This fact is accompanied by damage to health or fatalities caused to participants of accidents. [1]

Thorough cooperation of stakeholders as well as institutions can support significantly the smooth railway operation. Therefore, it becomes necessary to evaluate the situation and take measures while considering both the complex and partial situation solution processes.

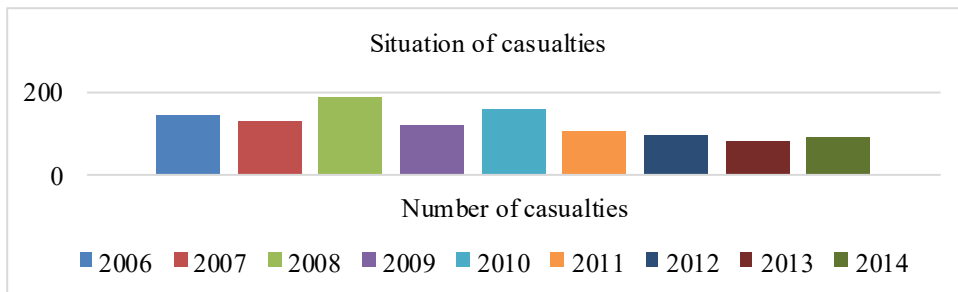
The available statistical data characterized the situations as follows: in the Czech Republic, a total of 1,100 accidents with 1,083 fatalities happened on the railways within the period 2006-2014.

Year	Number of accidents	Number of casualties
2006	233	141
2007	115	126
2008	133	183
2009	113	118
2010	125	155
2011	99	103
2012	97	92
2013	91	76
2014	104	89

Table 1 Number of rail accidents in the Czech Republic and number of relevant casualties [2]



Graph 1 Number of rail accidents in the Czech Republic [2]



Graf 2 Number of relevant casualties in the Czech Republic [2]

Although the shipment by rail seems comparatively safe, it is not entirely without risk. The accidents occurrence is affected by aspects such as human factor, technical condition of the train, technical condition of railway superstructure natural conditions as well as the transported goods. The risk and affects are much higher in case of shipping hazardous substances.

## 2.1 Risk assessment

Nowadays, there are high requirements for performance and work effort of employees; they dominate the threat resulting in working environment safety. Employers often do not realize that safe workplace can improve the quality of the entire work process.

Considering all the factors affecting the safe working environment is the basis for risks assessment in the work process.

Risk analysis is a method for identifying and assessing factors, which may threaten individual activities and objectives of the organization. We can use it for the risks identification, to which the enterprise is exposed to in terms of external and internal perspectives. It is based on identification of risks factors, developing scenarios, assessing the likelihood and consequences, and, finally,

financial costs, in case that the emergency occurs. It is the basis for risk management and prevention of crisis situations in the enterprise. [2]

The point method, extended risk definition, was selected to assess risk in our case. The point method is classified as one of most frequently used methods for risks assessment. The level of risk is expressed by combining the value of the likelihood of risks, possible consequence and the effect of the occupational safety and health (OSH); having assessed, it is assigned to the relevant group of final risk. This method is focused on the protecting human life.

$$R (\text{risk}) = P (\text{probability}) \times D (\text{consequence}) \times V (\text{effect of OSH level}), [3]$$

P – probability establishes the option estimation that the undesirable event occurs. It is expressed by assigning specific numbers 1 - 5 (Table 2),

D – consequence expresses the seriousness of the consequence of the emergency occurrence; it is defined by five stages with assigned values from 1 to 5 (Table 3),

V – OSH level impact: this parameter comprises consideration of management level, the time of action period of threats, staff qualification, work ethic, the level of prevention, condition and age of technical equipment, maintenance level, the effect of work environment, workplace detachability, etc. (Table 4).

Point value	Verbal expression
1	Improbable
2	Random
3	Probable
4	Highly probable
5	Permanent

Table 2 Probability estimation [4]

Point value	Verbal expression
1	Negligible effect on probability and injury consequences
2	Little effect on probability and injury consequences
3	Considerable effect
4	Significant, big effect
5	More significant effects

Table 3 Consequence estimation [4]

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Point value	Verbal expression
1	Damage to health and work activity
2	Injury followed by sick leave
3	More serious injury resulting in hospitalization
4	Severe occupational injury with permanent consequences
5	Fatal occupational injury

Table 4 OSH impact estimation [4]

Risk – final indicator, which is the product of all three parameters of the risk value. The lowest value can reach 1 and the highest 125. According to point range, the risk is classified into five categories. (Table 4).

Risk	Risk category	Point range	Safety assessment	Safety measures requirement
Negligible	I	1-4	Acceptable safety	Taking measures not required
Moderate	II	5-10	Acceptable risk at increased attention	System is classified as safe; improvement can be achieved, redress can be planned
Critical	III	11-50	Risk cannot be accepted without taking protective measures	Safety measures should be taken
Undesirable	IV	51-100	Inadequate safety, high possibility of injuries	Immediate corrective measures or short-term measures have to be taken
Unacceptable	V	100-125	Dangerous system, permanent threat of injury	Immediate cessation of activity, exclusion from operation

Table 5 Final risk range [4]

## 2 Point method application while transporting hazardous substances by rail

The carriage of hazardous substances by rail accounts for a significant share of total rail freight. Emergencies as well as accidents occur at shipping process resulting from hazardous substances characteristics. Number and scope of rail accidents is affected by many factors, which can be called causes resulting in consequences of various extents.

Each hazardous substance has its characteristics, according to which the material should be packed, loaded and stowed, shipped via adequate route and unloaded. The employees are frequently a significant element at giving rise to an accident: it is caused by activities, either intentional non-compliance with regulations and rules or by ignorance. These accidents affect the smooth flow of work process and shipping hazardous substances and threaten the very persons involved as well as people around. They may also affect significantly the property of residents within the accident as well as the environment (soil and water contamination, air toxic pollution). Therefore, all the time it is necessary to inspect and train the staff being focused on preventing accidents. The following table highlights the possible threats, which might arise during the rail-transport work process.

Number	Responsible action	Profession	Possible threat due to non-compliance with regulations
1.	Goods loading	loader	- goods loading, which may react together, omitting the tank failure (rupture), failure to comply with test date, improper packaging (certified package of I, II, III group) and goods labelling, damage to goods, incorrectly completed waybill, inappropriate use of wagon for the particular goods
2.	Tank labelling	shipper	- assigning wrong UN code, excessive number of pieces, overload, assigning improper parameters to a particular category of hazardous substances, different data in waybill in terms of labelling tanks/wagons or particular content
3.	Tank cleaning	tank cleaner	- failure to comply with the rules on safety equipment, sparking at a soiled tank - threat to health state of an employee (fatality)

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4.	Train dispatch	conductor and chief guard	- faulty inspection of the train formation and brakes, improper connecting and disconnecting rail vehicles
5.	Maintenance of train-set and tanks	train maintenance worker	- tank leaks, unclosed dome lid, cracks, bulging, violent damage, improper securing the bottom valve, missing protective caps, blind fastening screws (leakage of hazardous substance, fire, explosion)
6.	Track maintenance	track engineer	- neglected maintenance of tracks, sliding rails, not removing snow, icing, vegetation, outdated track (derailment)
7.	Security devices inspection	Railway transport worker-specialist (shunter, train dispatcher, switchman, switch supervisor, signalman, announcer, level-crossing operator)	- improper position of sliding rail/derailer, forgotten stop (derailment), faulty signalling (collision with a car, person)
8.	Shipping process	engine driver	- demanding route (steep descent, sharp bends), collisions with objects, cars, people, gases leakage into the environment
9.	Loading inspection	security advisor	- improper purchase of vehicles, faulty testing of means of transport, inadequately trained staff

Table 6 Application of point method for expressing threat and risk identification

Number	Risk value P x D x V	Risk category
1.	2 x 2 x 3 12	III
2.	3 x 3 x 2 18	III
3.	2 x 4 x 5 40	III
4.	3 x 3 x 2 18	III
5.	4 x 5 x 4 80	IV
6.	2 x 3 x 2 12	III
7.	2 x 3 x 4 24	III
8.	2 x 3 x 3 12	III
9.	2 x 2 x 1 4	I

Table 7 Results of point method

## 4 Proposal of measures to reduce risks

Risks presented in table 6, to a greater or lesser extent, affect the occurrence of accidents and emergencies. Knowledge of possible threats can result in taking measures, which might encourage risk reduction or elimination.

Rail transport brings risks of different levels. Some risks are determined by illegal action of a third party (terroristic attack, criminality); therefore, these threats cannot be controlled properly.

List of threats resulting from the assessment of risks in terms of transporting hazardous substances by rail:

- rigorous assessment of the particular goods characteristics and safe loading,
- modernization and inspection of used wagons and security devices,
- improvement and checking used packaging/containers,
- inspection of proper filling and pumping tanks,
- thorough inspection of labelling and marking wagons,
- data checking in a waybill and wagon labelling/marking,
- observing number of loaded units, not overloading wagons,
- applying adequate protective equipment and compliance with regulations at tank cleaning,



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- regular and complex inspection of the technical condition of the train, tanks and brakes,
- observing time-period checks,
- rigorous track inspection,
- tracks modernization,
- regular removing obstacles from the railway track (vegetation, snow, icing),
- weather forecasting and thorough evaluation of transport options,
- assessing and selecting route that is appropriate for shipping,
- goods inspection while transported,
- timely reporting in case of a terrorist attack or other unlawful entry of a third party,
- assessment and investigation of accidents and their causes so that recurrence of accidents due to same causes could be avoided,
- proper planning of work process,
- responsible performing work by employees,
- creating friendly work environment by superiors,

regular training: acquainting employees with risks, which might affect their work, work process knowledgeability, knowledge and compliance with relevant legislation, compliance with OSH, knowledge to provide first aid help.

## **5 Conclusions**

Nowadays, risk identification belongs to a significant and inseparable prevention component leading to higher quality and safer working environment. The point method application does not have to provide objective assessment, and final risk determination does not result in accurate values. However, its benefit consists in identification of risks, which threaten the smooth transport by rail. Risks assessment results are highly significant for taking suggested measures encouraging occupational health.

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